Evaluation of the NCEP Regional Reanalyses over Complex Terrain
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Introduction

This study is directed to the GAPP Science Question: what is the role of hydrologic prediction in coupled land atmosphere modeling? Specifically, this research is encapsulated in the synthesis product: *Provide a regional reanalysis of the atmospheric and land surface states using state-of-the-science numerical modeling and data assimilation systems.* The two main objectives of this project have been: (1) to evaluate how well the North American Regional Reanalyses (NARR) capture the morphology of major winter storms and (2) to downscale the NARR to a high resolution grid spacing. Progress towards these two objectives during the second year of this project is summarized below. Adjustment and refinement of project plans for year 3 are presented for each objective as well. Because of other research commitments, Dr. Steven Lazarus, original co-PI on this project, is no longer working directly on this project.

Evaluation of the North American Regional Reanalyses

M.S. graduate student Greg West and co-PIs Jim Steenburgh and Will Cheng have been evaluating characteristics of the North American Regional Reanalyses (NARR). Greg has completed his M.S. thesis entitled: *Spurious Grid-Scale Convection in the North American Regional Reanalysis*. This thesis is attached. A paper is in preparation and is intended to be submitted to *Mon. Wea. Rev.*: Spurious Grid-Scale Precipitation in the North American Regional Ranalysis by W. J. Steenburgh, G. West, and W. Cheng.

Case studies have illustrated that spurious grid-scale precipitation (SGSP) result in grid-scale updrafts, relative humidity/precipitable water maxima, equivalent potential temperature maxima, and absolute vorticity maxima. SOME SGSP events also feature anomalous low-level cold pools and sea level pressure maxima. The geographic and temporal distribution of events suggest that SGSP is rare (<100 cases per year) in the NARR prior to 2003. After precipitation assimilation changes made in 2003, however, cases of SGSP became more frequent (>2000 cases per year) due to a processing error in the precipitation assimilation over the oceans. The following two figures highlight the geographic and temporal distributions of the SGSP events. These results were discussed with NCEP staff in spring 2005 and at roughly the same time a processing error of the CMORPH precipitation dataset was discovered by NCEP staff that contributed to the sharp increase in the number of SGSP events after 2003.

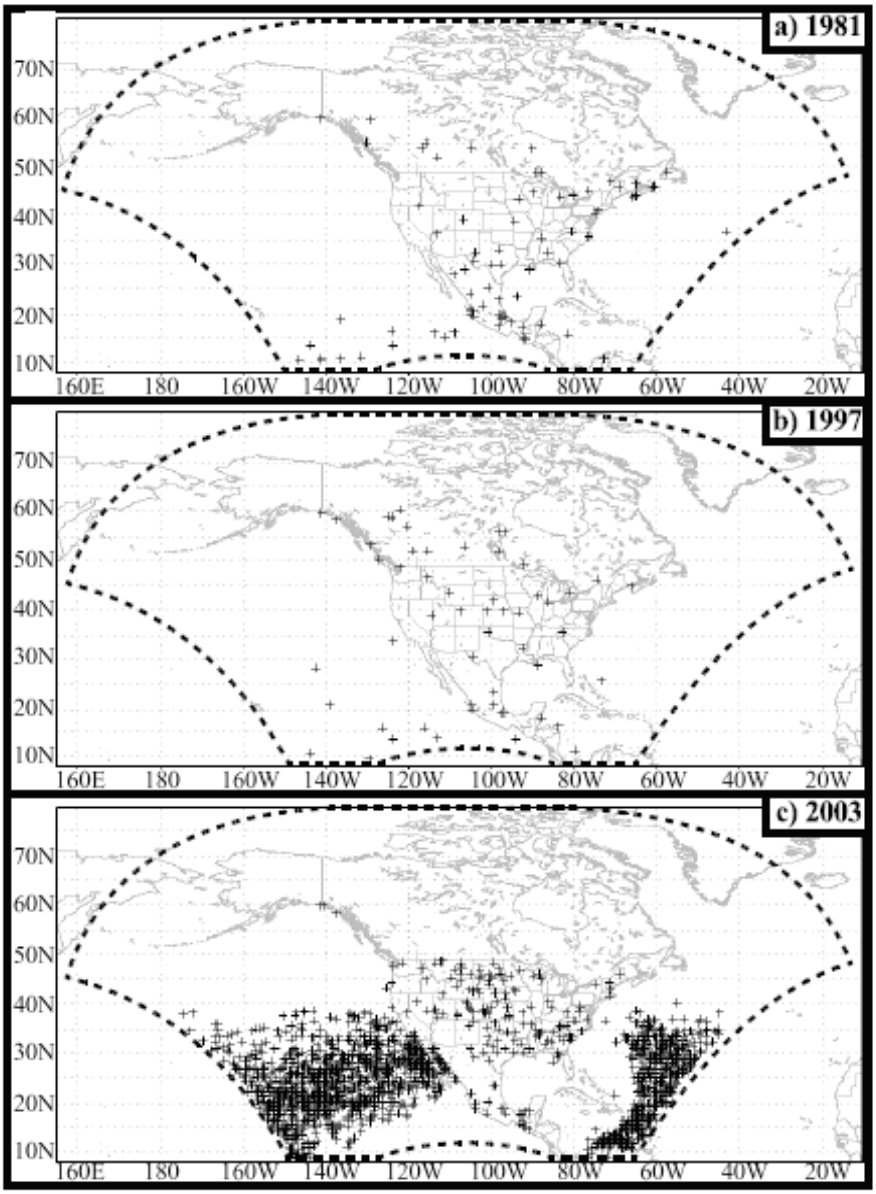
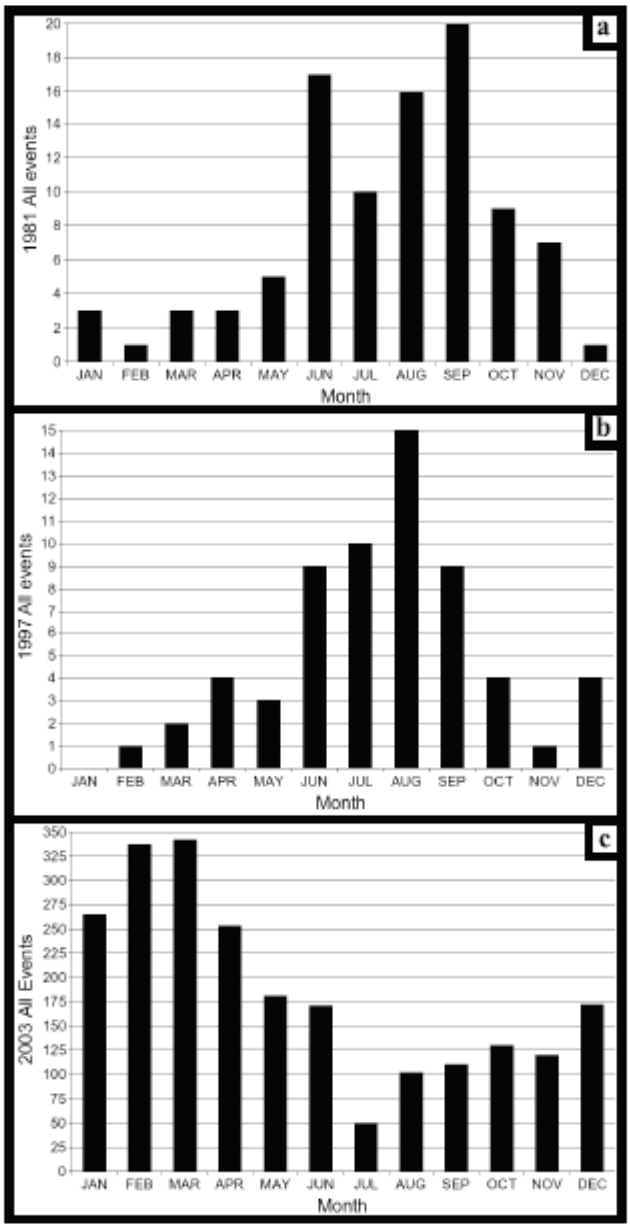


Figure 4.1. Locations of SGSC events in the NARR in (a) 1997, and (b) 2003. Dashed



Although not tied directly to the core goals of this research project, PhD. graduate student Jason Shafer analyzed 700 mb temperature fields for the entire NARR period of record (1979-2003) in order to assess both the quality of the NARR as well as objectively evaluate the occurrence of strong fronts over the West. He has completed his thesis entitled: *Topographic and diabatic influences on baroclinic storm evolution over the Intermountain West.*

During FY06, we will examine reruns of the post-2003 NARR in order to assess whether the number of SGSP events has been decreased. In addition, we will emphasize evaluation of the performance of the NARR during specific cases of heavy precipitation throughout the West. We are assembling data for a number of heavy precipitation events

during the 1987 winter storm cycle as well as heavy precipitation events throughout the southern tier of Western states during January 2005. Extensive verification assets during this later period make evaluation of the characteristics of the NARR and R-CDAS more straightforward than for earlier periods.

Based upon information presented by the EMC NARR project team at the NARR Workshop in January 2005, some of the research plans for FY06 have been modified. For example, it will not be possible to evaluate differences resulting from the different states of soil moisture during the overlapping analysis periods as only the analyses from the end of each production cycle have been archived. In addition, access to the analyses on the model's native grid is not possible nor is BUFR soundings at specific grid points available easily from the existing archive. These limitations of the archiving of the NARR data sets have hampered our investigations as it has been difficult to assess quantitatively the spatial and temporal details of the NARR reanalyses.

Downscaling the NARR

PhD. graduate student David Myrick and co-PI John Horel have been investigating methods to downscale coarse resolution analyses to high resolution surface grids. A paper describing some of this work entitled "Local adjustment of the background error correlation for surface analyses over complex terrain" has been published in *Weather and Forecasting*, 20, 149-160.

PI John Horel has been involved with efforts of the NWS Office of Science and Technology to develop a high resolution (order 5 km) analysis of record that could eventually provide retrospectively a mesoscale version of the NARR. A meeting summary has been recently published (*Bulletin of the American Meteorological Society*, 86, 1477-1480). There is considerable interest to facilitate development of a high-resolution analysis beyond the pioneering efforts of the NARR.

PIs Will Cheng and Jim Steenburgh have been evaluating the WRF model in order to lead to future improvements in its data assimilation and modeling system. A paper entitled "Evaluation of Surface Sensible Weather Forecasts by the WRF and ETA Models over the Western United States" is in press in *Weather and Forecasting*. This evaluation of the surface sensible weather forecasts uses high density observations provided by the MesoWest cooperative networks and illustrates the performance characteristics of the Cooperative Institute for Regional Prediction (CIRP) Weather Research and Forecast (WRF) and Eta models over the western United States during the 2003 warm season. processes to produce more accurate surface sensible weather forecasts.

During FY06, coordination with EMC staff will continue in order to test the 2DVAR version of their EDAS and WRF data assimilation systems. The goal of this evaluation is to assess to what extent the 2DVAR approach can be used to downscale the operational RUC and eventually lead to downscaling the NARR. The first step is to contribute information on observational errors in existing mesonet data assets for application in the NCEP Real-Time Mesoscale Analysis and compare existing downscaling approaches developed at the University of Utah with the more sophisticated downscaling being tested

by NCEP. All analysis systems require information on observational errors (both measurement and representativeness errors), yet this information is difficult to quantify for different mesonet networks. The sensitivity of the observational and background errors to the characteristics of the underlying terrain will also be explored.